THE INFLUENCE OF SOIL TYPE ON THE COMPOSITION AND YIELD OF WHITE OAK LEAVES

BY
JOHN STANLEY McVICKAR
A.B., University of Illinois, 1935
M.S., University of Illinois, 1939

AN ABSTRACT OF A THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
AGRONOMY IN THE GRADUATE SCHOOL OF
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Introduction and Procedure

The importance of vegetation in the development of soils long has been recognized. Numerous writers have referred to the chemical composition of tree leaves but there have been no exhaustive attempts to correlate the elemental composition of tree leaves with the replaceable base content of the soils on which the trees grew.

It was the purpose of this investigation to determine whether soil type influences the composition and yield of white oak leaves. It was necessary to know whether leaf position and directional exposure had any influence on leaf composition before starting to collect leaf samples to determine what, if any, influences soil differences have on leaf composition. Leaf samples, each sample consisting of 300 leaves from each of six white oak trees, three growing on a deep loess soil and three on a widely different soil in the same county were collected for the preliminary study. Besides the samples taken in late May, middle July and middle September, an additional set of leaf samples was taken in the fall of the first year of study to determine seasonal trends in leaf composition.

No significant differences in the chemical composition of leaves from the bottom, middle and topmost portions of the crown of white oak trees could be detected. The preliminary study indicated that the concentrations of the various bases in the leaves fluctuated during the growing season but for the purposes of the project it seemed that a sampling period in July, under Illinois conditions, represented a time of approximate non-fluctuation in elemental composition of white oak leaves. Sampling at that one time during each season enabled the writer to investigate a greater number of areas. By varying the date of sampling from south to north in Illinois, allowance was made for differences in time of the beginning of the growing season, thus leaves of comparable

physiological age were taken in every instance. Accordingly, the principal variable on leaf composition was that found among the replaceable base content of the Grey-Brown Podzolic soils supporting the white oak leaves.

During the third year of the investigation the study was broadened to observe the effects of leaf litter on soil development. Therefore litter samples were taken from two forested areas, one in northern and the other in southern Illinois. A method for randomized sampling of leaf litter is discussed in the paper.

Summary and Conclusions

This study, to be conclusive, should have been carried through a period of years longer than the writer was able to devote to it. Nevertheless the following pertinent findings are submitted:

1. It would seem that the height factor was of influence on the chemical composition of tree leaves only when there are marked variations in the extent of exposure to sunlight for different portions of the crown.

2. It was shown that the percentage of Ca in the leaf advanced with the season, while the Mg content remained fairly constant throughout the growing season. The concentrations of K, P and N in white oak leaves decreased as the season advanced.

3. Since observed chemical differences in leaf composition varied greater from year to year than from one soil type to another, it cannot be said that the chemical composition of white oak leaves varied with the soil type. Application of Spearman's formula failed to indicate any correlation between the replaceable base content of the soil types and the chemical composition of the leaves from trees growing thereon. It seems that the ability of the roots of the white oak tree to forage for the essential mineral constituents in the soil is such that even soils comparatively low in replaceable bases contain them in amounts adequate for the purposes of leaf growth.

4. From the limited amount of data, it appears that the

more fertile soil tends to support a larger tree growth and thus yields more leaf litter than a less fertile soil because of this factor.

Computed on a water free basis the yield of total leaf litter was 3421 ± 585 pounds per acre per year for the Bluford silt loam while the comparable value for the Clinton silt loam was 4493 ± 449 pounds.

From the standpoint of basal areas of the trees, the yield of leaf dry matter per sq. ft. of tree basal area was approximately 48 pounds for both forested areas.

5. Based on the current values of the essential elements contained the manurial value of the annual leaf litter from the Richland County area (Bluford silt loam) was estimated at slightly more than $4.00 per acre, while the comparable figure for the Marshall County woodlot (Clinton silt loam) was approximately $5.25 per acre.

The expense of collecting and handling the leaves would be greater than their value, thus making their use inadvisable by farmers other than in the forest habitat where the physical effects of the litter cover on forest propagation probably far exceeds any manurial value in terms of dollars and cents.

6. Any attempt to determine by mathematical procedure the number of years required for the trees to have deposited the total quantity of litter found in a given area would appear to result in unreliable values unless the history and treatment of that woodlot were fairly well understood.

7. It would seem that once equilibrium had been reached between the leaf litter and the A_0 horizon, any subsequent change in the lower profile is due to factors other than trees. After this equilibrium is established the only conservation of bases through vegetational effects is that resulting from a decreased movement of water through the lower profile, since there would be considerable loss of moisture to the atmosphere due to transpiration by the leaves and evaporation from the moist soil and litter beneath the trees. Once the above equilibrium is established the Ca and Mg contents of the mineral portion of the soil profile are not altered thereafter by the trees except as the leaves are removed, in which case the pro-

file would be depleted of material in a ratio of 3.45 Ca to 1 of Mg, which was found to be the average value for the ratio of Ca to Mg being deposited in the leaf litter.

VITA

The author was born May 12, 1909, at Sumner, Illinois, where he attended grade school and high school, graduating in June of 1926.

The author matriculated at Blackburn College in the fall of 1926 and spent one year as a student there. After teaching grade school for one year, he returned to Blackburn and graduated in 1929, with the highest scholarship of the year. The following year was spent as a student at Illinois State Normal University.

From 1930 until 1937, the author served as teacher and principal in the grade schools of Lawrence County, Illinois, attending summer sessions at the University of Illinois, where the B. A. degree was received in August, 1935. In September of 1937, he entered the Graduate School of the University of Illinois, where the M. S. degree was received in February of 1939. From September of 1938 until June of 1942, when he became a Student Instructor at Chanute Field, the author was half-time assistant in the Department of Agronomy of the University of Illinois.

The author is a member of Gamma Alpha, Alpha Tau Alpha, Gamma Sigma Delta, Sigma Xi, Ecological Society of America, American Society of Agronomy and is a member of Sumner Lodge No. 334 A. F. and A. M. and of Harmony Chapter No. 35 R. A. M. of Sumner, Illinois.

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